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FLIGHT SIMULATOR VISUAL SYSTEM RESEARCH AND DEVELOPMENT: A COMPREHENSIVE BIBLIOGRAPHY

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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

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13. ABSTRACT *(Maximum 200 words)*

This bibliography contains 1,610 references to research and development efforts accomplished over the past 25 years concerning flight simulator visual systems. It includes related work that may be of interest to the flight simulation community. The bibliography encompasses journal articles, technical reports and papers, and conference proceedings. The references are categorized according to the subject matter that is addressed in the cited publication. Overall, there are 45 various subject categories.

14. SUBJECT TERMS

Area of interest; Helmet-mounted displays; Eye movement; Field of view; Flight simulators; Flight simulation; Head Movement; Holographic; Images; Imaging; Motion perception; Simulator sickness; Scene content; Steroeoscopic; Variable acuity; Vision; Visual system

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REFERENCES (continued)

PREFACE

The present bibliography was prepared at the Aircrew Training Research Division of the Armstrong Laboratory to provide a comprehensive reference source for those engaged in the design and use of flight simulator visual systems. This effort was supported by the University of Dayton Research Institute, Contract No. F33615-90-C-0005, in conjunction with Work Unit Nos. 1123-03-85, Flying Training Research Support, and 1123-32-03, Tactical Scene Content Requirements. The Armstrong Laboratory contract monitor was Ms. Patricia A. Spears. The work unit monitor was Dr. Elizabeth L. Martin.

FLIGHT SIMULATOR VISUAL SYSTEM RESEARCH AND DEVELOPMENT: A COMPREHENSIVE BIBLIOGRAPHY

INTRODUCTION

A vast number of research and development efforts have been accomplished over the past 25 years directed toward improving the training effectiveness of the out-the-window visual scenes in flight simulators. In these efforts, the minimum requirements for a variety of visual simulation characteristics were determined for different types of simulated aircraft and flight tasks. Additionally, various advanced visual systems capable of producing more detailed and realistic scenes were developed and implemented. The results of this work have been disseminated to the flight simulator community through presentations at international and national technical conferences, Government and industry technical reports, and scientific journal publications.

To aid in identifying the past work for reference purposes in future visual simulation endeavors, the present bibliography was prepared. This bibliography contains 1,610 different references and spans the period from 1970 to the present. There are no references to classified material, and references to distribution-controlled Government publications are omitted.

Organization and Content

The references contained in this bibliography are categorized according to the subject about which they are concerned. Overall, the references are partitioned into 45 subject categories, as follows:

1. Visual Simulation Overview
2. Visual System Technologies
3. Helmet-Mounted Displays

4. Area-of-Interest Displays
5. Variable-Acuity Displays
6. Visual System Characteristics
7. Visual Cue Requirements
8. Scene Content
9. Visual Database Development
10. Networked Visual Simulation
11. Display Field of View
12. Scene Texture
13. Display Color
14. Display Luminance
15. Image Contrast and Sharpness
16. Display Resolution
17. Display Interlacing and Antialiasing
18. Collimation and Accommodation
19. CRT and Phosphor Characteristics
20. Display Update Rate
21. Display Flicker and Jitter
22. Display Distortion and Screen Characteristics
23. Display Seams, Display Joints, and Windscreen Quality
24. Image Processing, Bandwidth, and Spatial Frequency
25. Display Magnification and Gray Scale
26. Visual and Motion System Integration
27. Transport Delay
28. Video Projection
29. Stereoscopic Displays
30. Holographic Displays
31. Low-Altitude Flight Simulation
32. Aerial Refueling Simulation
33. Night Simulation

34. Eye Movement Characteristics
35. Head Movement Characteristics
36. Optical Flow
37. Blur Patterns and Looming
38. Motion Perception (Vection)
39. Human Vision Characteristics
40. Visual Target Acquisition
41. Image Quality Measurement
42. Visual Contributions to Simulator Sickness
43. Simulation Evaluation
44. Collision Detection and System Calibration
45. Research Requirements

Some of the references are applicable to more than one subject category, for example, display field of view and scene content. In such cases, the same references were repeated in each of the appropriate categories.

References to work that did not actually concern flight simulation are included because the subject matter may be of interest to the flight simulation community. Category 40, Visual Target Acquisition, for example, includes references to research addressing the visual detection distances of different aircraft types under real-world flight conditions, which may be useful for determining the level-of-detail and resolution requirements for flight simulator visual systems. Similarly, category 41, Image Quality Measurement, provides various references to research that, even though not specifically related, may be generalizable to flight simulation.

The references contained in this bibliography were obtained in the following manner. Initially, an extensive literature search was conducted through the Technical Information Service Office of the University of Dayton Research Institute. Five major information databases were searched:

DTIC (Defense Technical Information Center)

NASA (National Aeronautics and Space Administration)

Ei COMPENDEX PLUS (produced by Engineering Information, Inc.)

PsychINFO (produced by the American Psychological Assoc.)

INSPEC (Information Services for Physics, Electronics, and Computing)

Subsequently, a large number of conference proceedings, technical reports, and journal articles were individually reviewed by the author to locate other relevant references for inclusion in the bibliography. These publications were obtained from government and contractor personnel and the technical library at the Aircrew Training Research Division of the Armstrong Laboratory, as well as from Arizona State University and the University of Arizona. Also, selected publications were obtained from Wright-Patterson Air Force Base and the University of Dayton. Approximately half of the references contained herein are from this supplementary literature search.

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3. HELMET-MOUNTED DISPLAYS

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7. VISUAL CUE REQUIREMENTS

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8. SCENE CONTENT

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12. SCENE TEXTURE

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28. VIDEO PROJECTION

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